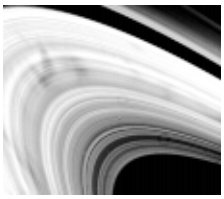
Rotating Rings of Ice

Saturn's rings have intriguing features.



LESSON TIME

May be carried out over two or three days. Activities are 20 to 30 minutes in duration

PREPARATION TIME

30 minutes

MATERIALS CHECKLIST

- *Black construction paper (9 x 12)*
- *7-inch paper plates*
- *Glue and scissors*
- *Black markers*
- *Styrofoam balls*
- *Vermiculite*
- *Copies of "Saturn Paragraph Graphic Organizer" for students*
- *Writing paper; pencils*
- *Science Notebooks*

STUDENT PREREQUISITES

Students should have some familiarity with Saturn and its rings.

LESSON NO. 7

Language Arts Focus — Drafting and Writing a Paragraph
Science Focus — Modeling Saturn's Icy Ring System

OVERVIEW

In this lesson, students take a closer look at the rings of Saturn. Each student will create a three-dimensional model of Saturn and its rings. The model will show the particle nature and structure of the rings. Students also write about the model in this lesson. With the aid of a graphic organizer, students organize their thoughts, then draft and write a paragraph to explain what they know about the ring system.

BACKGROUND

People have been looking at Saturn for a very long time. It is visible to the naked eye as a bright object in the night sky. The ancient Romans named the planet after their god of agriculture. But it wasn't until 1610 that anyone actually saw Saturn's rings. That's when Galileo looked at the planet through one of the world's first telescopes. His telescope wasn't powerful enough to show the rings clearly, and Galileo mistakenly thought he was looking at a triple planet. In 1655, a Dutch astronomer named Christiaan Huygens looked at Saturn through a more powerful telescope and observed that the planet was surrounded by a giant flat ring. Saturn's rings have become one of the great, enduring mysteries of our solar system. Though we know considerably more about the rings since Huygens observed Saturn, there is still much to learn.

Objectives

Students will:

1. Create a three-dimensional model of Saturn and its rings.
2. Show that the rings are made of particles of varying sizes.
3. Indicate the Cassini Division between the A and B rings.
4. Learn that the rings revolve around Saturn in a counterclockwise fashion as seen from above Saturn's north pole.
5. Use a graphic organizer as a pre-writing tool.
6. Draft and write a short paragraph describing the rings of Saturn.

Teacher Preparation

Make copies, one per student, of the "Saturn Paragraph Graphic Organizer" worksheet. You may wish to make a transparency of the worksheet for modeling. Print out a copy of the "Graphic Organizer Summary" (see page 6) for yourself to use to structure the class discussion of how to extend students' ideas on their graphic organizers into complete sentences for a paragraph. Gather materials, enough so that each student will receive one piece of 9 x 12 black construction paper, one 7-inch paper plate, writing paper, plus pencils, markers, glue, and scissors. Allow one 2-1/4-inch Styrofoam ball for each student; allow some time to cut the balls in half — each student will receive two halves. For one part of the lesson, you will be recording student responses on chalkboard, whiteboard, or chart paper. This lesson provides teacher information on the rings that can be adapted for classroom use as a handout or for teacher use as a transparency — "The Structure of Saturn's Rings" (see page 7). For more information on Saturn and its rings, visit the Cassini–Huygens website at: *http://saturn.jpl.nasa.gov*

Procedure

Allow 40 minutes for model building and 30 minutes for writing. If you intend to have students write a final version, you may wish to extend the activity to a third day.

Day One

Starting the Model — 20 minutes

1. Distribute one 7-inch paper plate to each student. Explain to students that they will be building a three-dimensional model of Saturn and its rings.
2. Show students how to locate the raised inner portion of the paper plate and ask students to cut along its outer edge — they will end up with a circle about 4 inches across.
3. Ask students what is located between the A ring and the B ring of Saturn. If they do not know, explain that it is the Cassini Division and remind them to leave a gap in the rings.
4. Ask students to mark the Cassini Division by drawing a dark ring, using their black markers, about 1-1/2 inches from the center of the plate.
5. Distribute two halves of a Styrofoam ball to each student. Explain that the ball will represent Saturn in the model.
6. Have students glue one half of the ball to each side of the paper plate circle, placing the ball in the center of the circle.
7. Let the models dry before the completion phase.

Day Two

Completing the Model — 20 minutes

1. Return the models to the students. Engage students in a discussion and a series of questions to tap into their background knowledge of the Saturn and its rings. Some questions to frame your discussion might include:

- What orbits Saturn?
- What do the rings look like from Earth?
- How many rings are there?
- How would you describe the rings?
- What do you think they are they made of?
- Is there something on Earth that reminds you of the rings?
- Why do you think they are around Saturn?

2. After your discussion, explain to students that they will be adding Saturn's rings to complete their models.
3. Model for students how to make several concentric rings of glue on the paper plate. Place your first ring about 1/2 inch from the edge of the ball. Remind students to keep the dark circle marking the Cassini Division free of glue!
4. While the glue is still wet, have the students liberally sprinkle their paper plates with vermiculite. Remove the excess vermiculite and allow the model to dry.
5. To demonstrate the orbiting rings, place the model on a table top and give it a quick counterclockwise turn. Ask students a few questions to encourage thinking about the model:
   - What do you see when the model is turned quickly?
   - What do the rings look like when the model is spinning?
   - Do the rings look solid or like individual pieces of ice?

With this model students can see for themselves that if particles orbit quickly enough, they do, in fact, look solid!

Writing about Saturn's Rings — 30 minutes

1. Explain to students that they will be writing about Saturn and its rings.
2. Have students form pairs and brainstorm about Saturn and its icy rings. After their brainstorming, ask students for some of their ideas and record them on chart paper or the board.
3. Show students a copy of the "Saturn Paragraph Graphic Organizer" worksheet and explain its three sections. Model how to use it to organize some of the ideas students have generated in their brainstorming. You might want to use an overhead projector to make it easier for students to follow along.
4. Examples of ideas you might note on your example:
   - Main idea: Saturn has rings.
   - Three supporting ideas:
     1. Rings — frozen water
     2. Some small, some big chunks of ice
     3. Gaps — Cassini Division
   - Conclusion: Saturn is a special planet.

5. Distribute a "Saturn Paragraph Graphic Organizer" to each student and have the students complete their copies with their own ideas.
6. After students have completed their "Saturn Paragraph Graphic Organizer," model how to extend the ideas on your example organizer into complete sentences for a paragraph. You may find the "Graphic Organizer Summary" (see page 6) useful as you structure the discussion.

   Example of possible paragraph:

   Saturn has rings of ice. Saturn is cold and its rings are chunks of frozen water. Some of the chunks are small and some are big. The rings have many gaps. The biggest one is the Cassini Division. Rings make Saturn a special planet.
7. Using the ideas in their organizers, have students write a first draft of their paragraphs. (You may have to give them a third day to rewrite paragraphs in final form for publication.)
8. Students' writing can be added to their portfolios or displayed in the classroom with their models.

teacher TIP

Make sure you have a large container to catch the excess bits and pieces of vermiculite!

Using Science Notebooks

Writing prompts for this lesson:

1. Focus question: What do you know about Saturn's rings and what do you think they are made of?
2. Process question: How did your model change when you gave it a spin?

Why This Works

Through this activity, students can bring Saturn — a very, very distant object — into their own classrooms. The experience of manipulating a tangible object, in this case a small model, can help students grasp new information. With the help of the Saturn model, students can observe the particle nature of the ring system. The model not only gives them "first-hand" experience of the orbiting rings, but it also provides an experience that can serve as the basis for their writing. The graphic organizer included in this lesson is a useful writing tool that supports students as they sort out their ideas in preparation for writing a paragraph. For beginning writers, graphic organizers have been found to be an essential tool for internalizing new information. They also allow students to sequentially organize their ideas and their subsequent writing.

Assessment

Students' models and writing (in their paragraphs and Science Notebooks) will reflect what they have learned about the nature of Saturn's rings. The model should show multiple rings and a gap indicating the Cassini Division. Student writing should include accurate capitalization and punctuation. The paragraph should include a main idea, two to three supporting sentences, and a brief conclusion.

Standards

NCTE Standards for the English Language Arts

- Students read a wide variety of print and nonprint texts to build an under standing of texts, of themselves, and the world.
- Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), and genre to create, critique, and discuss print and nonprint texts.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Students participate as knowledgeable, reflective, creative, and critical members of a variety of literacy communities.
- Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning for enjoyment, persuasion, and the exchange of information).

National Science Education Standards

Physical Science

- Position and motion of objects

Earth and Space Sciences

- Objects in the sky

Graphic Organizer Summary

1 TOPIC SENTENCE–MAIN IDEA:

What you plan to prove or explain (can be the focus question of the lesson turned into a statement)

2 DETAIL/FACT/CLAIM

Data/information to back up your detail/fact/claim: What is your evidence?

3 DETAIL/FACT/CLAIM

Data/information to back up your detail/fact/claim: What is your evidence?

4 DETAIL/FACT/CLAIM

Data/information to back up your detail/fact/claim: What is your evidence?

5 CONCLUSION

Restate your position, use synonyms,
remind reader of your topic,
convince your audience or challenge them
to think about or apply what you have written.
You might even share a new question.

The Structure of Saturn's Rings

Saturn's beautiful rings have been photographed through Earth-based telescopes, but because Saturn is so distant, details of both the planet and the rings have been difficult to see. Cassini–Huygens will be the fourth robotic spacecraft to visit and photograph Saturn close up. The first was Pioneer 11 in 1979. Pioneer 11's view of Saturn was about 50,000 times closer than any Earth-based telescope could see. When the two Voyager spacecraft flew by Saturn during the 1980s, they took many photographs and beamed them to Earth, and human beings were finally able to see some of the most subtle colors and structure in the rings. The Hubble Space Telescope, observing distant objects from Earth orbit, has also taken a number of photographs of the famous ringed planet.

Yet the rings still hold many mysteries. Some of the questions that scientists working on the Cassini–Huygens mission to Saturn hope to answer about the rings are:

- How do the ring particles interact with each other?
- Are there more moons hidden in the rings?
- How old are the rings?
- What is their source?
- What is the composition of the rings?

While Saturn is not the only planet in our solar system with rings, it is certainly the planet that is most famous for its rings. It is worth noting that Saturn's rings are compositionally unique in the solar system. While the rings of the outer planets Jupiter, Neptune, and Uranus are made primarily of dust grains or other dark material, Saturn's rings are mostly water ice. For more information on Saturn's ring system, visit:

http://saturn.jpl.nasa.gov/science/rings.cfm

http://www.jpl.nasa.gov/saturn/back.html

http://www.windows.ucar.edu/tour/link=/saturn/saturn_rings.html&edu=elem
(for young readers)

When you first look at Saturn, you might be tempted to think there are only two rings around the planet. But this is not so — in fact, there are many, many rings orbiting Saturn. Viewing Saturn from Earth, we can see that the ring system is divided into several radial zones and each of the zones is made up of many rings.

Scientists named the rings using a system of letters. Seven ring zones have been identified, beginning with the A ring and ending with the G ring. The order of rings from inner to outer is D, C, B, A, F, G, E. (The rings are not located in alphabetical order outward from the planet because they were named in order of their discovery.) An outer "zone" of rings, which is visible to Earth observers, is referred to as the A ring and the brighter inner zone is known as the B ring. the gap between the two zones (B and A) is named the Cassini Division. If viewing conditions are just right, observers on Earth can also see the C ring — an inner, semitransparent ring.

Beyond the A, B, and C rings, Saturn has several other distinct rings: the D, F, and G rings. These last three rings were all detected in images taken by the Pioneer and Voyager spacecraft as they flew past Saturn.

The distance between the rings is not constant. Some rings are relatively close together, like the rings making up the A and B rings. Others have quite a bit of space between them, like the rings that make up the C ring.

The rings of Saturn are very wide and they have differing diameters. The A ring — the outer zone of the main rings — has a diameter of about 273,000 kilometers (nearly 170,000 miles). The E ring has a diameter of about 965,000 kilometers (nearly 600,000 miles). To appreciate the size of Saturn's rings, consider that the A ring would fit quite nicely into the space between Earth and our Moon.

The rings are wide, but not very thick — scientists estimate the A and B rings to be between 100 meters (300 feet) and 10 meters (30 feet) in thickness. Even though the rings are very thin, we can see them from Earth because of the Sun's light reflecting off the particles of ice that make up the rings.

Seen up close by Cassini, the rings may be even more surprising. The particles that make up the rings vary in size from as small as a few micrometers to a few meters in size. The rings are mainly water ice. Some scientists have described the particles that make up the rings as icy snowballs. One of the questions scientists hope to answer is: What are the rings made of?

The structure of the rings is also interesting. From Voyager we learned that the thin F ring has a number of strands that appear to be intertwined and "braided" in some places and "kinked" in others. Some rings even contain small moons. Surely, the Cassini–Huygens mission will also discover new and unexpected information about the mysterious rings!